Using Response Surface Methods to Correlate the Modal Test of an Inflatable Test Article

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This paper presents a practical application of response surface methods (RSM) to correlate a finite element model of a structural modal test. The test article is a quasi-cylindrical inflatable structure which primarily consists of a fabric weave, with an internal bladder and metallic bulkheads on either end. To mitigate model size, the fabric weave was simplified by representing it with shell elements. The task at hand is to represent the material behavior of the weave. The success of the model correlation is measured by comparing the four major modal frequencies of the analysis model to the four major modal frequencies of the test article.

Given that only individual strap material properties were provided and material properties of the overall weave were not available, defining the material properties of the finite element model became very complex. First it was necessary to determine which material properties (modulus of elasticity in the hoop and longitudinal directions, shear modulus, Poisson's ratio, etc.) affected the modal frequencies. Then a Latin Hypercube of the parameter space was created to form an efficiently distributed finite case set. Each case was then analyzed with the results input into RSM. In the resulting response surface it was possible to see how each material parameter affected the modal frequencies of the analysis model. If the modal frequencies of the analysis model and its corresponding parameters match the test with acceptable accuracy, it can be said that the model correlation is successful.

Background Information:
Anju Gupta has been a structures analyst in the structures group at the Johnson Space Center since September 2010. Her main focus area is stress analysis using FEA. She is also working towards developing an understanding of fracture mechanics. She completed her B.S. in mechanical engineering from The Ohio State University in June 2010. While at Ohio State, she was a part of the coop program at JSC completing tours in both the structures and robotics groups.